



2017

LRFD Bridge Construction Specifications

4th Edition



AMERICAN ASSOCIATION
OF STATE HIGHWAY AND
TRANSPORTATION OFFICIALS

AASHTO

AASHTO Publication Code: LRFDCONS-4
ISBN: 978-1-56051-666-8



2017

LRFD Bridge Construction Specifications

4th Edition



AMERICAN ASSOCIATION
OF STATE HIGHWAY AND
TRANSPORTATION OFFICIALS

AASHTO

AASHTO Publication Code: LRFDCONS-4
ISBN: 978-1-56051-666-8



American Association of State Highway and Transportation Officials
444 North Capitol Street, NW, Suite 249
Washington, DC 20001
202-624-5800 phone/202-624-5806 fax
www.transportation.org

Cover photos: **Top:** Erection of the basket handle steel arch of the Edna M. Griffin pedestrian bridge over I-235 in downtown Des Moines, Iowa, during an overnight closure, July 3rd, 2003. Photo provided by Iowa DOT. **Bottom:** Utah South Layton Span 1 over I-15, in Layton, Utah, August 8, 2010. Photo provided by the Utah DOT.

© 2017 by the American Association of State Highway and Transportation Officials. All rights reserved. Duplication is a violation of applicable law.

AASHTO EXECUTIVE COMMITTEE 2016–2017

Voting Members

OFFICERS:

PRESIDENT: David Bernhardt, Maine*

VICE PRESIDENT: John Schroer, Tennessee*

SECRETARY-TREASURER: Carlos Braceras, Utah

EXECUTIVE DIRECTOR: Bud Wright, Washington, D. C.

REGIONAL REPRESENTATIVES:

REGION I: Leslie Richards, Pennsylvania
Pete Rahn, Maryland

REGION II: Charles Kilpatrick, Virginia
James Bass, Texas

REGION III: Randall S. Blankenhorn, Illinois
Patrick McKenna, Missouri

REGION IV: Carlos Braceras, Utah
Mike Tooley, Montana

***Elected at the 2016 Annual Meeting in Boston, Massachusetts**

Non-Voting Members:

Immediate Past President: Vacant

Executive Director: Bud Wright, Washington, DC

HIGHWAY SUBCOMMITTEE ON BRIDGES AND STRUCTURES, 2016

GREGG FREDRICK, *Chair*

BRUCE V. JOHNSON, *Vice Chair*

JOSEPH L. HARTMANN, Federal Highway Administration, *Secretary*

PATRICIA J. BUSH, *AASHTO Liaison*

ALABAMA, Eric J. Christie, William “Tim” Colquett, Randall B. Mullins
ALASKA, Richard A. Pratt
ARIZONA, David B. Benton, David L. Eberhart, Pe-Shen Yang
ARKANSAS, Charles “Rick” Ellis
CALIFORNIA, Susan Hida, Thomas A. Ostrom, Dolores Valls
COLORADO, Behrooz Far, Stephen Harelson, Jessica Martinez
CONNECTICUT, Timothy D. Fields
DELAWARE, Barry A. Benton, Jason Hastings
DISTRICT OF COLUMBIA, Donald L. Cooney, Konjit C. “Connie” Eskender, Richard Kenney
FLORIDA, Sam Fallaha, Dennis William Potter, Jeff Pouliotte
GEORGIA, Bill DuVall, Steve Gaston
HAWAII, James Fu
IDAHO, Matthew Farrar
ILLINOIS, Tim A. Armbrecht, Carl Puzey
INDIANA, Anne M. Rearick
IOWA, Ahmad Abu-Hawash, Norman L. McDonald
KANSAS, Mark E. Hoppe, John P. Jones
KENTUCKY, Mark Hite, Marvin Wolfe
LOUISIANA, Arthur D’Andrea, Paul Fossier, Zhengzheng “Jenny” Fu
MAINE, Jeffrey S. Folsom, Wayne Frankhauser, Michael Wight
MARYLAND, Earle S. Freedman, Jeffrey L. Robert, Gregory Scott Roby
MASSACHUSETTS, Alexander K. Bardow, Thomas Donald, Joseph Rigney
MICHIGAN, Matthew Jack Chynoweth, David Juntunen
MINNESOTA, Arielle Ehrlich, Kevin Western
MISSISSIPPI, Austin Banks, Justin Walker, Scott Westerfield
MISSOURI, Dennis Heckman, Scott Stotlemeyer
MONTANA, Kent M. Barnes, David F. Johnson
NEBRASKA, Mark Ahlman, Fouad Jaber, Mark J. Traynowicz
NEVADA, Troy Martin, Jessen Mortensen
NEW HAMPSHIRE, David L. Scott, Peter Stamnas
NEW JERSEY, Xiaohua “Hannah” Cheng, Nagnath “Nat” Kasbekar, Eli D. Lambert
NEW MEXICO, Ted L. Barber, Raymond M. Trujillo, Jeff C. Vigil
NEW YORK, Wahid Albert, Richard Marchione
NORTH CAROLINA, Brian Hanks, Scott Hidden, Thomas Koch
NORTH DAKOTA, Terrence R. Udland
OHIO, Alexander B.C. Dettloff, Timothy J. Keller
OKLAHOMA, Steven Jacobi, Walter Peters
OREGON, Bruce V. Johnson, Tanarat Potisuk, Hormoz Seradj
PENNSYLVANIA, James M. Long, Thomas P. Macioce, Lou Ruzzi
PUERTO RICO, (Vacant)
RHODE ISLAND, Georgette Chahine
SOUTH CAROLINA, Barry W. Bowers, Terry B. Koon, Jeff Sizemore
SOUTH DAKOTA, Steve Johnson
TENNESSEE, John S. Hastings, Wayne J. Seger
TEXAS, Bernie Carrasco, Jamie F. Farris, Gregg A. Freeby
U.S. DOT, Joseph L. Hartmann
UTAH, Carmen Swanwick, Cheryl Hersh Simmons, Joshua Sletten
VERMONT, James LaCroix, Wayne B. Symonds
VIRGINIA, Prasad L. Nallapaneni, Kendal R. Walus

WASHINGTON, Tony M. Allen, Thomas E. Baker, Bijan Khaleghi
WEST VIRGINIA, Ahmed Mongi, Billy Varney
WISCONSIN, Scot Becker, William C. Dreher, William Olivia
WYOMING, Paul G. Cortez, Gregg C. Frederick, Michael E. Menghini

GOLDEN GATE BRIDGE, HIGHWAY AND TRANSPORTATION DISTRICT, Kary H. Witt
MDTA, Dan Williams

N.J. TURNPIKE AUTHORITY, Richard J. Raczynski
N.Y. STATE BRIDGE AUTHORITY, Jeffrey Wright
PENN. TURNPIKE COMMISSION, James Stump

U.S. ARMY CORPS OF ENGINEERS—DEPARTMENT OF THE ARMY, Phillip W. Sauser, Christopher H. Westbrook

U.S. COAST GUARD, Kamal Elnahal

U.S. DEPARTMENT OF AGRICULTURE—FOREST SERVICE, John R. Kattell

KOREA, Eui-Joon Lee, Sang-Soon Lee

SASKATCHEWAN, Howard Yea

TRANSPORTATION RESEARCH BOARD, Waseem Dekelbab

ABBREVIATED TABLE OF CONTENTS

The *AASHTO LRFD Bridge Construction Specifications*, Fourth Edition, contains the following 33 sections:

1. Structure Excavation and Backfill
2. Removal of Existing Structures
3. Temporary Works
4. Driven Foundation Piles
5. Drilled Shafts
6. Ground Anchors
7. Earth-Retaining Systems
8. Concrete Structures
9. Reinforcing Steel
10. Prestressing
11. Steel Structures
12. Steel Grid Flooring
13. Painting
14. Stone Masonry
15. Concrete Block and Brick Masonry
16. Timber Structures
17. Preservative Treatment of Wood
18. Bearing Devices
19. Bridge Deck Joint Seals
20. Railings
21. Waterproofing
22. Slope Protection
23. Miscellaneous Metal
24. Pneumatically Applied Mortar
25. Steel and Concrete Tunnel Liners
26. Metal Culverts
27. Concrete Culverts
28. Wearing Surfaces
29. Embedment Anchors
30. Thermoplastic Culverts
31. Aluminum Structures
32. Shock Transmission Units
33. Micropiles

FOREWORD

The first broadly recognized national standard to design and construct bridges in the United States was published in 1931 by the American Association of State Highway Officials (AASHO), the predecessor to AASHTO. With the advent of the automobile and the establishment of highway departments in all of the American states dating back to just before the turn of the century, the design, construction, and maintenance of most U.S. bridges was the responsibility of these departments and, more specifically, the chief bridge engineer within each department. It was natural, therefore, that these engineers, acting collectively as the AASHTO Highways Subcommittee on Bridges and Structures, would become the author and guardian of this first bridge standard.

This first publication was entitled *Standard Specifications for Highway Bridges and Incidental Structures*. It quickly became the *de facto* national standard and, as such, was adopted and used by not only the state highway departments but also other bridge-owning authorities and agencies in the United States and abroad. The title was soon revised to *Standard Specifications for Highway Bridges* and new editions were released about every four years. AASHTO released the 17th and final edition in 2002.

The body of knowledge related to the design of highway bridges has grown enormously since 1931 and continues to do so. Theory and practice have evolved greatly, reflecting advances through research in understanding the properties of materials, in improved materials, in more rational and accurate analysis of structural behavior, in the advent of computers and rapidly advancing computer technology, in the study of external events representing particular hazards to bridges such as seismic events and stream scour, and in many other areas. The pace of advances in these areas has accelerated in recent years.

In 1986, the Subcommittee submitted a request to the AASHTO Standing Committee on Research to assess U.S. bridge design specifications, to review foreign design specifications and codes, to consider design philosophies alternative to those underlying the Standard Specifications, and to render recommendations based on these investigations. This work was accomplished under the National Cooperative Highway Research Program (NCHRP), an applied research program directed by the AASHTO Standing Committee on Research and administered on behalf of AASHTO by the Transportation Research Board (TRB). The work was completed in 1987, and, as might be expected with continuing research, the Standard Specifications were found to have discernible gaps, inconsistencies, and even some conflicts. Beyond this, the specification did not reflect or incorporate the most recently developing design philosophy, load-and-resistance factor design (LRFD), a philosophy which has been gaining ground in other areas of structural engineering and in other parts of the world such as Canada and Europe.

From its inception until the early 1970s, the sole design philosophy embedded within the Standard Specifications was one known as working stress design (WSD). WSD establishes allowable stresses as a fraction or percentage of a given material's load-carrying capacity, and requires that calculated design stresses not exceed those allowable stresses. Beginning in the early 1970s, WSD was adjusted to reflect the variable predictability of certain load types, such as vehicular loads and wind forces, through adjusting design factors, a design philosophy referred to as load factor design (LFD).

A further philosophical extension considers the variability in the properties of structural elements, in similar fashion to load variabilities. While considered to a limited extent in LFD, the design philosophy of LRFD takes variability in the behavior of structural elements into account in an explicit manner. LRFD relies on extensive use of statistical methods, but sets forth the results in a manner readily usable by bridge designers and analysts.

With this edition, the fourth, of the *AASHTO LRFD Bridge Construction Specifications*, Interim Specifications will no longer be issued. Instead, changes balloted and approved by at least two-thirds of the members of the Subcommittee will be published in the next full edition of the Specifications, to be published on a three-year cycle. AASHTO members include the 50 State Highway or Transportation Departments, the District of Columbia, and Puerto Rico. Each member has one vote. The U.S. Department of Transportation is a non-voting member.

Orders for Specifications may be placed by visiting our website, bookstore.transportation.org, or by calling 1-800-231-3475 (toll free within the U.S. and Canada). A free copy of the current publication catalog can be downloaded from our website or requested from the Publications Sales Office.

The Subcommittee would also like to thank Mr. John M. Kulicki, Ph.D., and his associates at Modjeski and Masters for their valuable assistance in the preparation of these LRFD Specifications.

AASHTO encourages suggestions to improve these specifications. They should be sent to the Chairman, Subcommittee on Bridges and Structures, AASHTO, 444 North Capitol Street, N.W., Suite 249, Washington, DC 20001. Inquiries as to intent or application of the specifications should be sent to the same address.

AASHTO Highways Subcommittee on Bridges and Structures
August 2017

PREFACE

Units

The *AASHTO LRFD Bridge Construction Specifications*, Fourth Edition, uses U.S. Customary units only. Per a decision by the subcommittee in 2009, SI units will no longer be included in this edition or future interims.

References

If a standard is available as a stand-alone publication—for example, the ACI standards—the title is *italicized* in the text and listed in the references. If a standard is available as part of a larger publication—for example, the AASHTO materials specifications—the standard’s title is not italicized and the larger publication—in this case, *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*—is listed in the references.

Unit Abbreviations

Most of the abbreviations commonly used in LRFD Construction are listed below. Also, please note the following:

- Abbreviations for singular and plural are the same.
- Most units of time have one-letter abbreviations. Unit abbreviations are always set in roman type, while variables and factors are set in *italic* type. Thus, “2 h” is the abbreviation for “two hours.”

Table i—Frequently-Used Unit Abbreviations

Unit	Abbreviation
cubic foot	ft ³
cubic inch	in. ³
cubic yard	yd ³
degrees Fahrenheit	°F
foot	ft
foot-kip	ft-kip
foot per hour	ft/h
foot per minute	ft/min
foot per second	ft/s
foot pound	ft · lb
foot pound-force	ft · lbf
foot second	ft · s
gallon	gal
hour	h
Hertz	Hz
inch	in.
joule	J
kilonewton	kN
kilopascal	kPa
kip per foot	kip/ft
kip per square inch	ksi
kip per square foot	kip/ft ²
megapascal	MPa
microinch	μin
micron	μm
mile	mi
minute	min (min. for “minimum”)

Table i (continued)—Frequently-Used Unit Abbreviations

Unit	Abbreviation
newton	N
newton meter	N · m
newton per meter	N/m
ounce	oz
pascal	Pa
pascal second	Pa · s
pound	lb
pound-force	lbf
pound-force foot	lbf · ft
pound-force inch	lbf · in.
pound-force per foot	lbf/ft
pound-force per inch	lbf/in.
pound-force per pound	lbf/lb
pound-force per square foot	psf
pound-force per square inch	psi
pound per cubic foot	lb/ft ³
pound per cubic inch	lb/in. ³
pound per cubic yard	lb/yd ³
pound per foot	lb/ft
pound per inch	lb/in.
pound per hour	lb/h
pound per square foot	lb/ft ²
pound per yard	lb/yd
radian	rad
radian per second	rad/s
quart	qt
second	s
square inch	in. ²
square foot	ft ²
square mile	mi ²
square yard	yd ²
year	yr

Note: There are no abbreviations for *day*, *degree* (angle), *kip*, *mil*, or *ton*.

AASHTO Publications Staff
August 2017

CHANGED AND DELETED ARTICLES, 2016 AND 2017

SUMMARY OF AFFECTED SECTIONS

The fourth edition revisions to the *AASHTO LRFD Bridge Construction Specifications* affect the following sections:

- 3. Temporary Works
- 10. Prestressing
- 11. Steel Structures
- 19. Bridge Deck Joint Seals
- 27. Concrete Culverts

SECTION 3 REVISIONS

Changed Articles

Section 3 has been replaced in its entirety.

SECTION 10 REVISIONS

Changed Articles

The following Articles in Section 10 contain changes or additions to the specifications, the commentary, or both:

10.3.2.3.2

Deleted Articles

No Articles were deleted from Section 10.

SECTION 11 REVISIONS

Changed Articles

The following Articles in Section 11 contain changes or additions to the specifications, the commentary, or both:

11.1.1	11.3.6.2	11.4.9.1	11.5.6.1	11.7.1
11.2.1	11.3.7	11.4.9.3	11.5.6.3	11.7.2
11.3.1.1	11.4.1	11.4.11	11.5.6.4.1	11.8.3.3.1
11.3.1.2	11.4.2	11.4.12.2.1	11.5.6.4.2	11.8.3.4
11.3.1.7	11.4.3.2	11.4.12.2.4	11.5.6.4.3	11.8.3.5
11.3.2.1	11.4.3.3.2	11.4.15	11.5.6.4.4	11.8.3.6.1
11.3.2.6	11.4.3.3.3	11.5.2	11.5.6.4.5	11.8.3.7.1
11.3.3	11.4.6	11.5.3.1	11.5.6.4.6	11.8.5.1
11.3.4.1	11.4.7	11.5.5	11.5.6.4.7	11.8.5.3
11.3.4.2	11.4.8.1.1	11.5.5.1	11.5.6.4.7a	11.8.5.5
11.3.5	11.4.8.1.4	11.5.5.4.1	11.5.6.4.7b	11.10
11.3.5.2	11.4.8.4	11.5.5.4.3	11.6.1	
11.3.6.1	11.4.8.5	11.5.5.4.8b	11.6.5	

Deleted Articles

11.3.1.3	11.3.1.6	11.3.2.4	11.5.6.4.8	11.8.3.4.2
11.3.1.4	11.3.2.2	11.3.2.5	11.5.7	11.8.3.4.3
11.3.1.5	11.3.2.3	11.5.5.3	11.8.3.4.1	11.8.3.6.3

SECTION 19 REVISIONS

Changed Articles

The following Articles in Section 19 contain changes or additions to the specifications, the commentary, or both:

19.2.2	19.3.2	19.4.3.2	19.7
19.3.1	19.4.3.1	19.4.3.3	

Appendix A19

3.1.5	5.1.2	5.3.1.1	5.3.3.2	5.3.4.5
3.1.9	5.1.3	5.3.1.2	5.3.4.2	5.3.5.1
4.1	5.2.2	5.3.2	5.3.4.3	5.3.5.2
5.1.1.4	5.3	5.3.3.1	5.3.4.4	

Deleted Articles

No Articles were deleted from Section 19.

SECTION 27 REVISIONS

Changed Articles

The following Article in Section 27 contains changes or additions to the specifications, the commentary, or both:

27.3.1	27.3.3.3	27.5.2.2	27.9
--------	----------	----------	------

Deleted Articles

No Articles were deleted from Section 27.

TABLE OF CONTENTS

1.1—GENERAL 1-1
1.2—WORKING DRAWINGS 1-1
1.3—MATERIALS 1-2
1.4—CONSTRUCTION 1-2
 1.4.1—Depth of Footings 1-2
 1.4.2—Foundation Preparation and Control of Water 1-2
 1.4.2.1—General 1-2
 1.4.2.2—Excavations within Channels 1-3
 1.4.2.3—Foundations on Rock 1-3
 1.4.2.4—Foundations Not on Rock 1-3
 1.4.2.5—Approval of Foundation 1-3
 1.4.3—Backfill 1-4
1.5—MEASUREMENT AND PAYMENT 1-4
 1.5.1—Measurement 1-4
 1.5.2—Payment 1-5
1.6—REFERENCE 1-6

STRUCTURE EXCAVATION AND BACKFILL

1.1—GENERAL

C1.1

Structure excavation shall consist of the removal of all material, of whatever nature, necessary for the construction of foundations for bridges, retaining walls, and other major structures, in accordance with the contract documents or as directed by the Engineer.

If not otherwise provided for in the contract, structure excavation shall include the furnishing of all necessary equipment and the construction and subsequent removal of all cofferdams, shoring, and water control systems which may be necessary for the execution of the work.

If not otherwise specified in the contract documents, it shall also include the placement of all necessary backfill, including any necessary stockpiling of excavated material which is to be used in backfill, and the disposing of excavated material which is not required for backfill, in roadway embankments, or as provided for excess and unsuitable material in Subsection 203.02, *AASHTO Guide Specifications for Highway Construction*.

If the contract does not include a separate pay item or items for such work, structure excavation shall include all necessary clearing and grubbing and the removal of existing structures within the area to be excavated.

Classification, if any, of excavation will be indicated in the contract documents and set forth in the proposal.

The removal and disposal of buried natural or man-made objects are included in the class of excavation in which they are located, unless such removal and disposal are included in other items of work. However, in the case of a buried man-made object, the removal and disposal of such object will be paid for as extra work and its volume will not be included in the measured quantity of excavation, if:

- its removal requires the use of methods or equipment not used for other excavation on the project;
- its presence was not indicated in the contract drawings;
- its presence could not have been ascertained by site investigation, including contact with identified utilities within the area; and
- the Contractor so requests in writing prior to its removal.

1.2—WORKING DRAWINGS

Whenever specified in the contract drawings, the Contractor shall provide working drawings, accompanied by calculations where appropriate, of excavation procedures, embankment construction, and backfilling operations. This plan shall show the details of shoring, bracing, slope treatment, or other protective system

Subsection 203.02 is located in the *AASHTO Guide Specifications for Highway Construction*.

proposed for use and shall be accompanied by design calculations and supporting data in sufficient detail to permit an engineering review of the proposed design.

The working drawings for protection from caving shall be submitted sufficiently in advance of proposed use to allow for their review; revision, if needed; and approval without delay to the work.

Working drawings shall be approved by the Engineer prior to performance of the work involved, and such approval shall not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

1.3—MATERIALS

Material used for backfill shall be free of frozen lumps, wood, or other degradable or hazardous matter and shall be of a grading such that the required compaction can be consistently obtained using the compaction methods selected by the Contractor.

Permeable material for underdrains shall conform to *AASHTO Guide Specifications for Highway Construction*, Subsection 704.01.

C1.3

Subsection 704.01 is located in the *AASHTO Guide Specifications for Highway Construction*.

1.4—CONSTRUCTION

1.4.1—Depth of Footings

The elevation of the bottoms of footings, as shown in the contract documents, shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevation of footings as may be necessary to secure a satisfactory foundation.

1.4.2—Foundation Preparation and Control of Water

1.4.2.1—General

Where practical, all substructures shall be constructed in open excavation and, where necessary, the excavation shall be shored, braced, or protected by cofferdams constructed in accordance with the requirements contained in Article 3.3, "Cofferdams and Shoring." When footings can be placed in the dry without the use of cofferdams, backforms may be omitted with the approval of the Engineer and the entire excavation filled with concrete to the required elevation of the top of the footing. The additional concrete required shall be furnished and placed at the expense of the Contractor. Temporary water control systems shall conform to the requirements contained in Article 3.4, "Temporary Water Control Systems."

1.4.2.2—Excavations within Channels

When excavation encroaches upon a live streambed or channel, unless otherwise permitted, no excavation shall be made outside of caissons, cribs, cofferdams, steel piling, or sheeting, and the natural streambed adjacent to the structure shall not be disturbed without permission from the Engineer. If any excavation or dredging is made at the site of the structure before caissons, cribs, or cofferdams are sunk or are in place, the Contractor shall, without extra charge, after the foundation base is in place, backfill all such excavation to the original ground surface or riverbed with material satisfactory to the Engineer. Material temporarily deposited within the flow area of streams from foundation or other excavation shall be removed and the stream flow area freed from obstruction thereby.

1.4.2.3—Foundations on Rock

When a foundation is to rest on rock, the rock shall be freed from all loose material, cleaned, and cut to a firm surface, either level, stepped, or roughened, as may be directed by the Engineer. All seams shall be cleaned out and filled with concrete, mortar, or grout before the footing is placed.

Where blasting is required to reach footing level, any loose, fractured rock caused by overbreak below bearing level shall be removed and replaced with concrete or grouted at the Contractor's expense.

1.4.2.4—Foundations Not on Rock

When a foundation is to rest on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation, and the final removal of the foundation material to grade shall not be made until just before the footing is to be placed.

Where the material below the bottom of footings not supported by piles has been disturbed, it shall be removed and the entire space filled with concrete or other approved material at the Contractor's expense. Under footings supported on piles, the over-excavation or disturbed volumes shall be replaced and compacted as directed by the Engineer.

1.4.2.5—Approval of Foundation

After each excavation is completed, the Contractor shall notify the Engineer that the excavation is ready for inspection and evaluation and no concrete or other footing material shall be placed until the Engineer has approved the depth of the excavation and the character of the foundation material.